# NETWORK PERFORMANCE FOR EMERGING SERVICES AND NON-HUMAN USERS

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Rohde & Schwarz  mobile network testing

ROHDE&SCHWARZ
Make ideas real

# 4G AND 5G NETWORK POLICIES TODAY

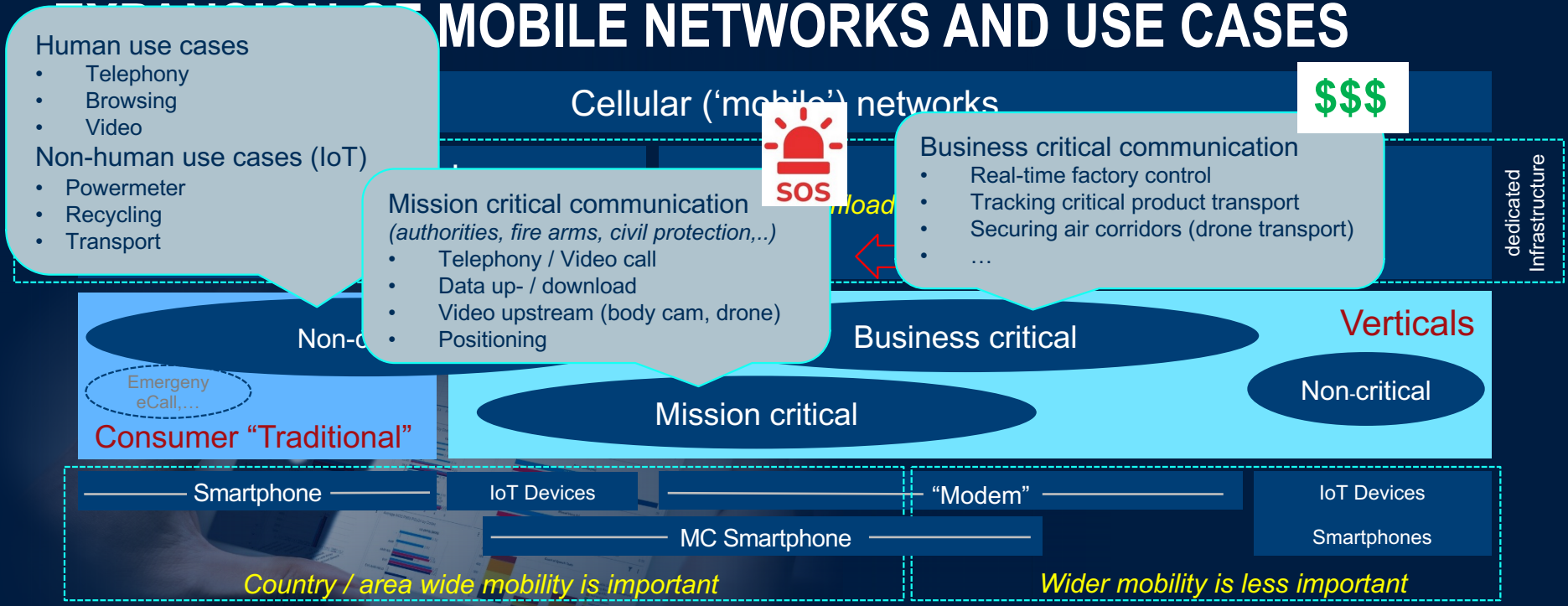
*High attention on peak data rates in todays 4G/5G networks*

- Today's mobile networks are designed and **optimized for human users**
- What human users are doing today?
  - Retrieving of web content (→ more than 'browsing')
  - Streaming video
  - Posting to social media
  - Voice and video calls over IP
  - …



- **Operators today mostly prioritize high data rates in DL direction**
- **'Performance' is often defined by 'maximum or average bitrate'. Is this sufficient?**

# EXPANSION OF MOBILE NETWORKS AND USE CASES



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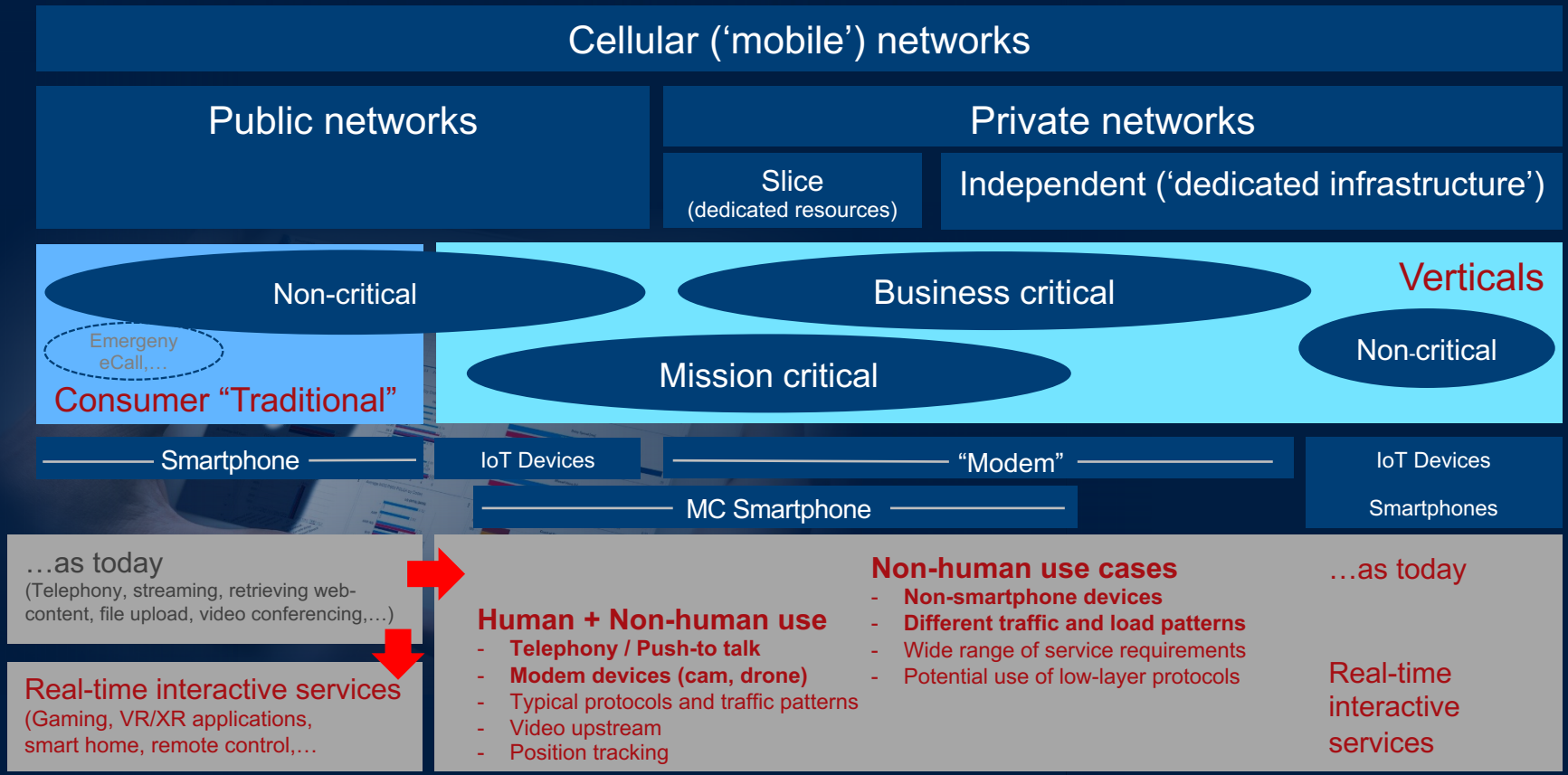


# F MOBILE NETWORKS AND USE CASES

QoS/QoE relevant actions

- Spectrum clearing
- Acceptance
- Network audit
  Performance evaluation
- Benchmarking
- Monitoring

Cellular (‘mobile’) networks

etworks

Private networks

Slice
(dedicated resources)

Independent (‘dedicated infrastructure’)

critical

Business critical

Verticals

Non-critical

Mission critical

Emergen
eCall,…

Consumer “Traditional”

Smartphone

IoT Devices

“Modem”

IoT Devices

Smartphones

MC Smartphone

…as today
(Telephony, streaming, retrieving web-content, file upload, video conferencing,…)

Real-time interactive services
(Gaming, VR/XR applications, smart home, remote control,…

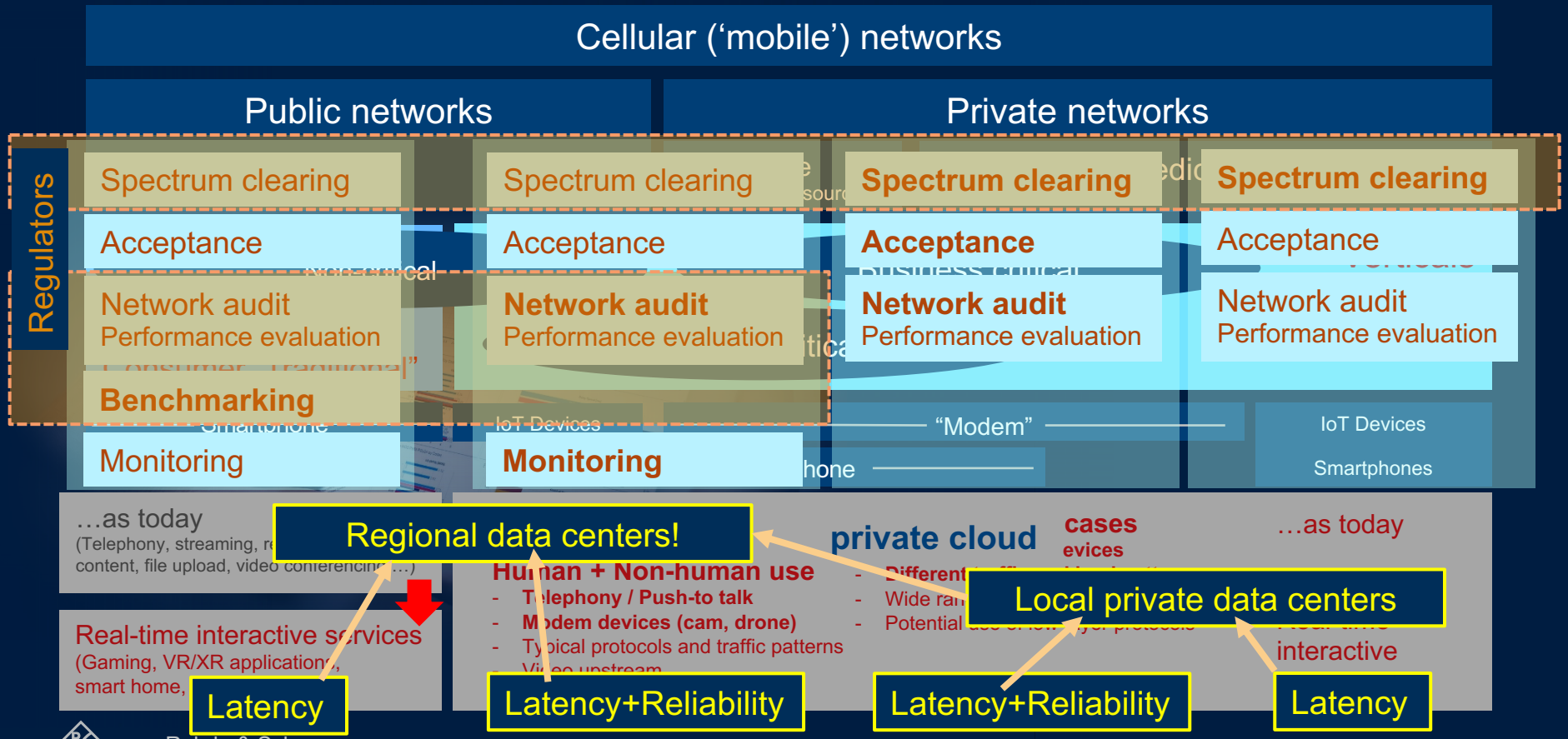
**Human + Non-human use**
- **Telephony / Push-to talk**
- **Modem devices (cam, drone)**
- Typical protocols and traffic patterns
- Video upstream
- Position tracking

**Non-human use cases**
- **Non-smartphone devices**
- **Different traffic and load patterns**
- Wide range of service requirements
- Potential use of low-layer protocols

…as today

Real-time interactive services

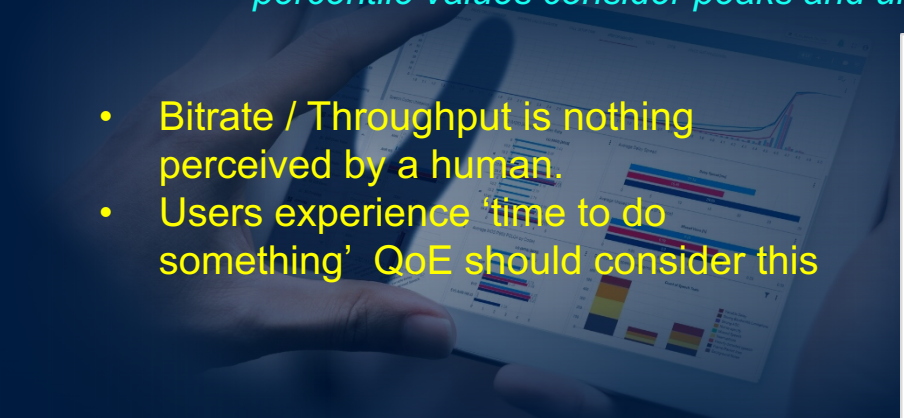
# EXPANSION OF MOBILE NETWORKS AND USE CASES



# CONSEQUENCES FOR TESTING NETWORK PERFORMANCE

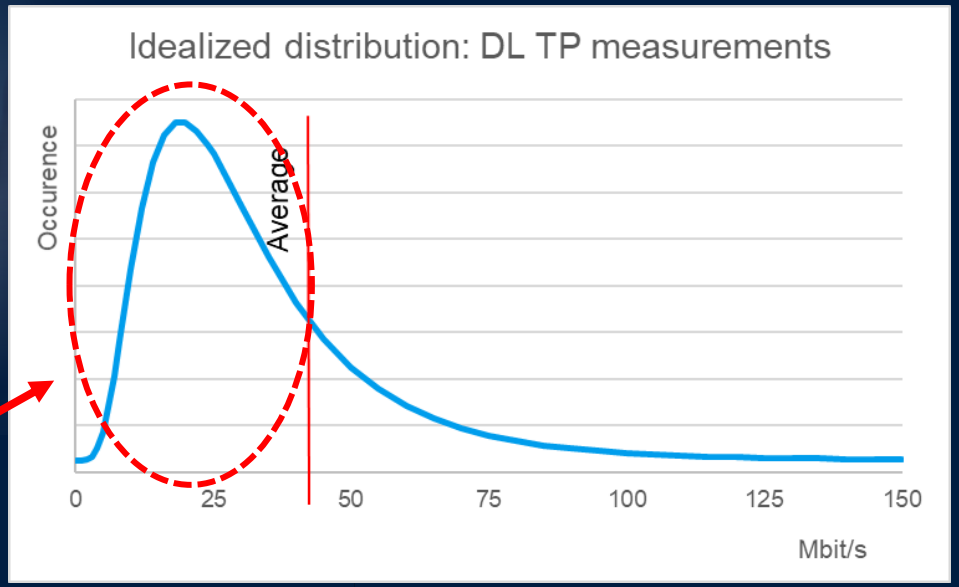
QoS

- QoS / technical KPIs to test?
  - Real-time, interactive services need KPIs based on short-term evaluation
  - Statistics must reflect more than ‘averages’
    *e.g. median instead of average for asymmetric distributed measurement values, percentile values consider peaks and undercuts*



- Bitrate / Throughput is nothing perceived by a human.
- Users experience ‘time to do something’ QoE should consider this

Vast majority of individual values below average.



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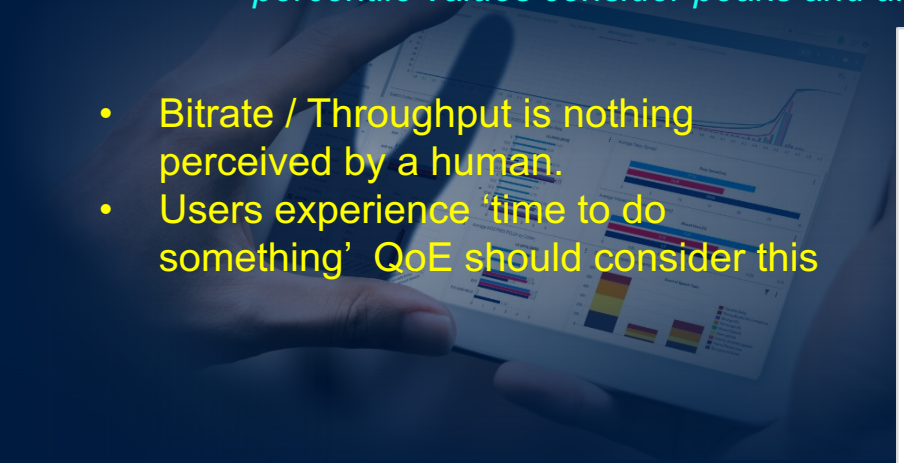

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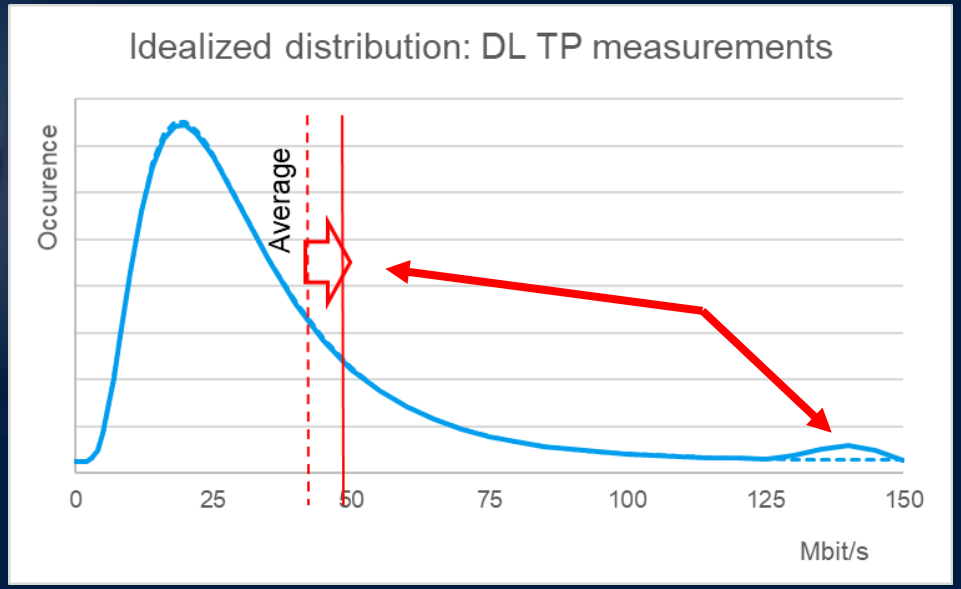

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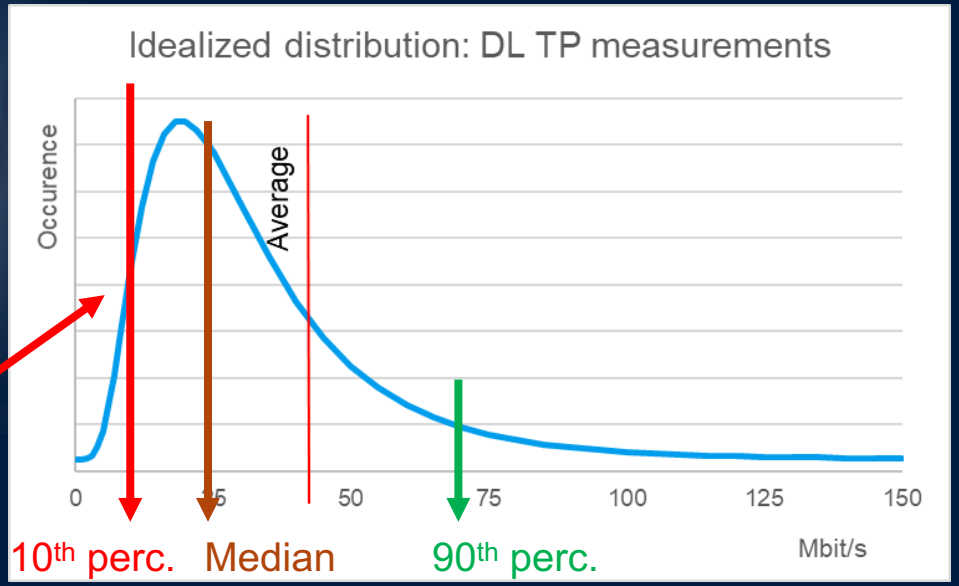
‘Percentiles ‘or ‘threshold-exceeding’

- Focus on weak performance and help to drill-down and to improve
- Applied in network performance scoring as in **ETSI TR 103 559**

This is critical for the users



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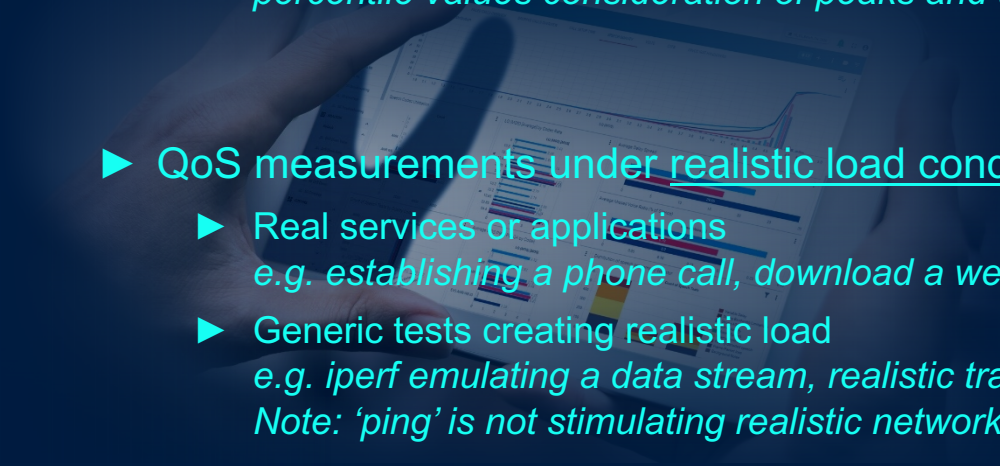


- QoS measurements under realistic load conditions
  - Real services or applications
    *e.g. establishing a phone call, download a web page, streaming a video*
  - Generic tests creating realistic load
    *e.g. iperf emulating a data stream, realistic transfer rates as in ITU-T Y.1540 or G.1051*
    *Note: ‘ping’ is not stimulating realistic network traffic*

# CONSEQUENCES FOR TESTING NETWORK PERFORMANCE

QoE

- How to define and to model QoE for use cases and applications?
  - Subjective Evaluation of QoE
  - Objective QoE models for automated field testing
  - Later: What is about ‘QoE’ for non-human use cases?

- There are defined test setups for many QoE evaluations
  - Examp
    - V ote person)
    - ( e for setup
  - Simila veb-content

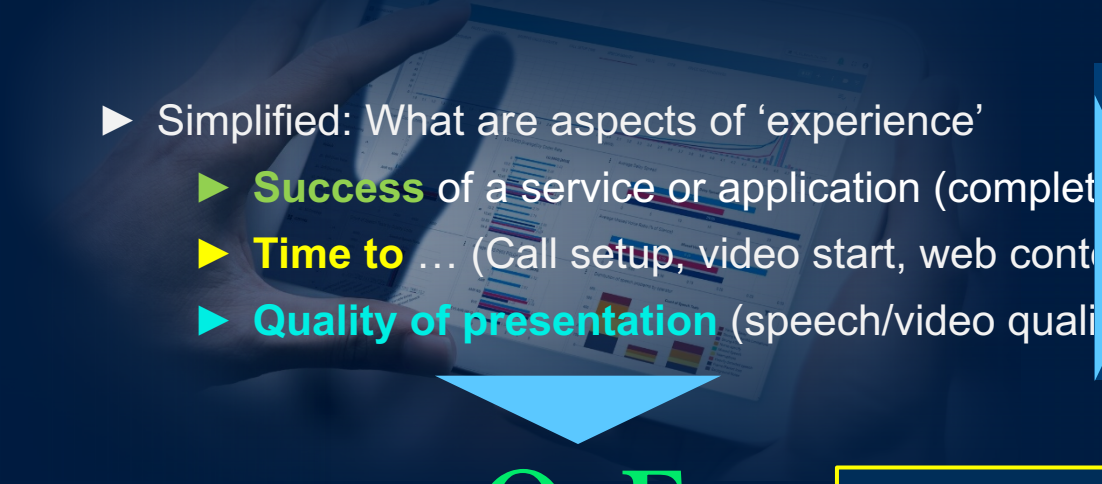
Accurate objective models exist today:
- Speech Quality ITU-T P.863 ‘POLQA’
- Video Quality ITU-T J.341.x, P.120y.x

…QoE of a service is more…

# CONSEQUENCES FOR TESTING NETWORK PERFORMANCE

- How to define and to model QoE for new use cases and applications?
  - Subjective Evaluation of QoE
  - Objective QoE models for automated field testing
  - What is about ‘QoE’ for non-human use cases?

QoE



- Simplified: What are aspects of ‘experience’
  - **Success** of a service or application (complet
  - **Time to** … (Call setup, video start, web cont
  - **Quality of presentation** (speech/video quali

QoE

- Many underlying QoS parameters
  - DNS resolution
  - Throughput, IP-Capacity
  - Latency, latency variation
  - Loss, discontinuous transmission

**→ How to apply in real field?**

# EVALUATION OF NETWORK PERFORMANCE

- Often ‘network performance’ is used equivalent to ‘data speed’ or ‘bitrate’
- Network performance is more, it should consider all dimensions of network use
  - *What are use cases or services and how important are they?*
  - *How to derive a QoE performance per service?*
- A network is not a single point, it is deployed region- or country-wide
  - *How to aggregate performance measures across a region or a country?*
- A network is not homogenous, not geographically and not technology-wise.
  - *How to consider a wide variation of local performances*
  - *How to stay technology-agnostic?*

# EVALUATION OF NETWORK PERFORMANCE
## TYPICAL USE CLASSES IN PUBLIC NETWORKS

| *P2P direct real-time connection* | *Continuous transfer of media, real-time* | *Up- or download files* | *Network performance on low layer* |
|---|---|---|---|
| Telephony | Streaming media<br>Online gaming | Messaging<br>Browsing<br>Social media<br>File transfer | Data speed |

Performance ‘scoring’ must cover **all aspects of network use**

# PERFORMANCE SCORE

# COVERS ALL USE CASE CLASSES

*P2P direct real-time connection*

## Telephony
- 2G/3G Call
- VoLTE Call
- WhatsApp (VoIP)

***Focus on mobile-to-mobile***

*Receiving / sending media w/ motion, real-time*

## Streaming media
- YouTube Full HD
- YouTube 4K
- Facebook Watch

*Up- or download files*

## Messaging
- SMS/RCS messaging
- WhatsApp messaging

## Social media
- Browsing (Retrieving)
- Posting
  - Facebook
  - Instagram
  - Twitter

## File transfer
- HTTP file transfer
- FTP file transfer

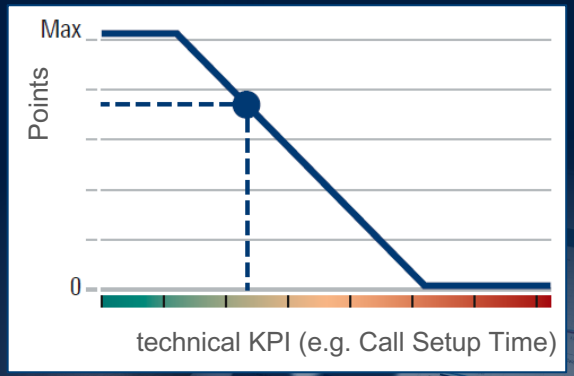
*Network performance on low layer*

## Data speed
- HTTP/TCP Capacity
- FTP Capacity
- UDP Capacity

## Transport latency
- UDP latency / Interactivity
- HTTP/TCP latency

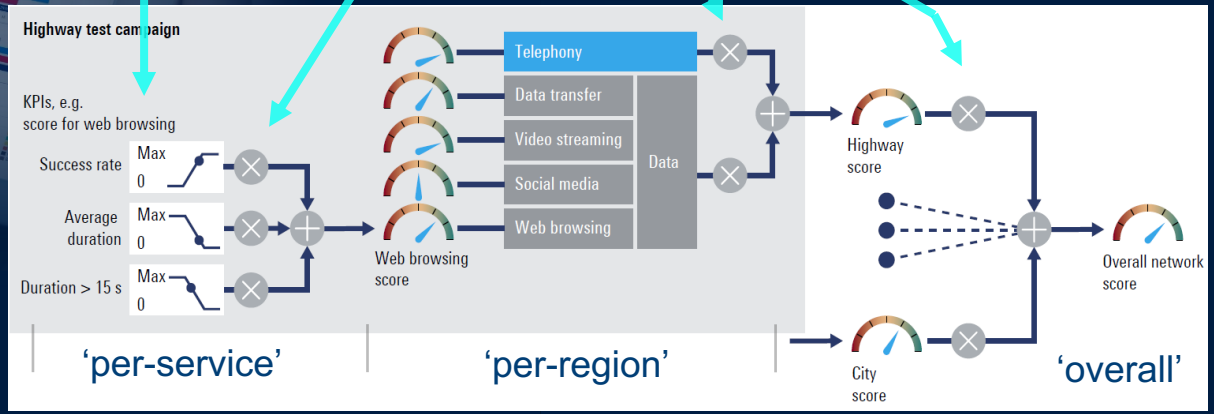
## Transport continuity
- iPerf3

# NETWORK PERFORMANCE SCORE
## IN PRINCIPLE: AN AGGREGATION MODEL




Each technical KPI is transformed to a **perceptual** point scale.
This makes the KPIs directly comparable (same scale).

Each KPI is weighted according to its importance and further combined and aggregated with other KPIs.

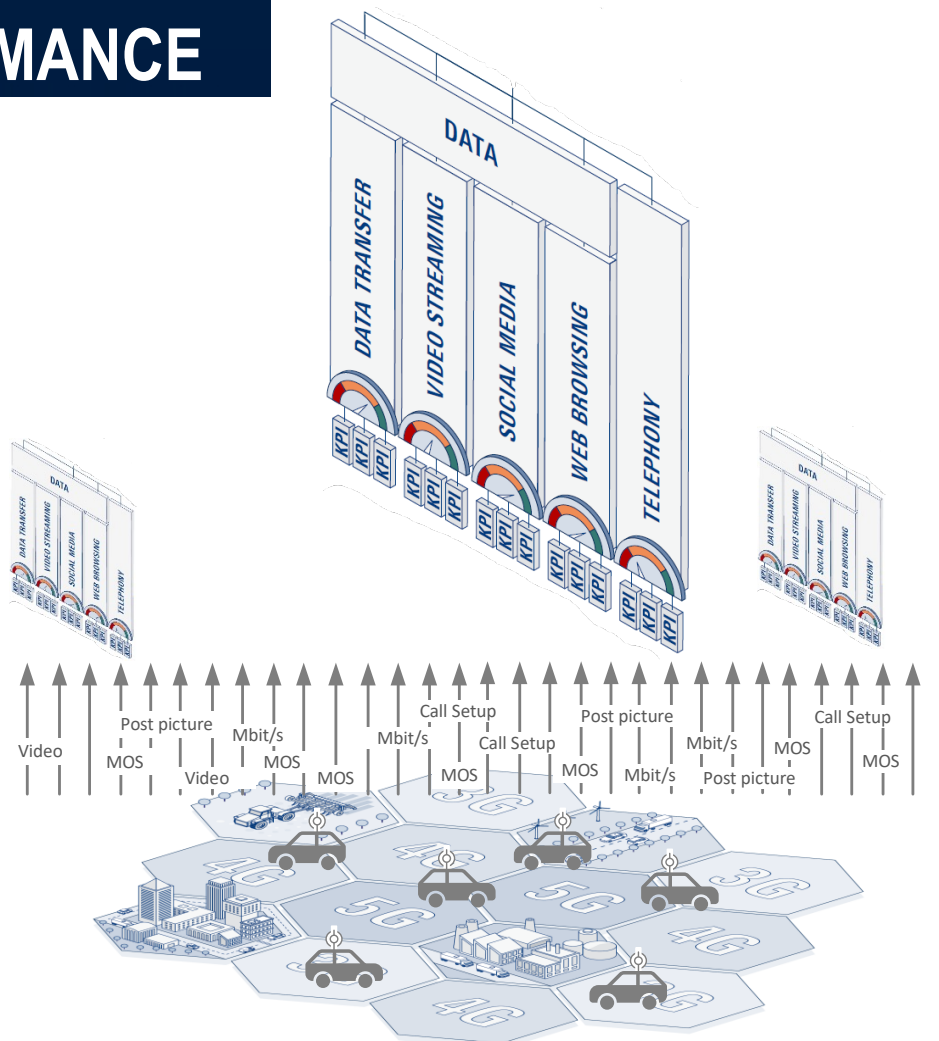


# SCORING NETWORK PERFORMANCE

**Integrated score per ‘service’**

All technical KPIs ‘as usual’ are measured, accessible and reported

You will not loose any detail!



# SCORING NETWORK PERFORMANCE

Integrated score ‘overall’

Integrated score per ‘region’

Integrated score per ‘service’

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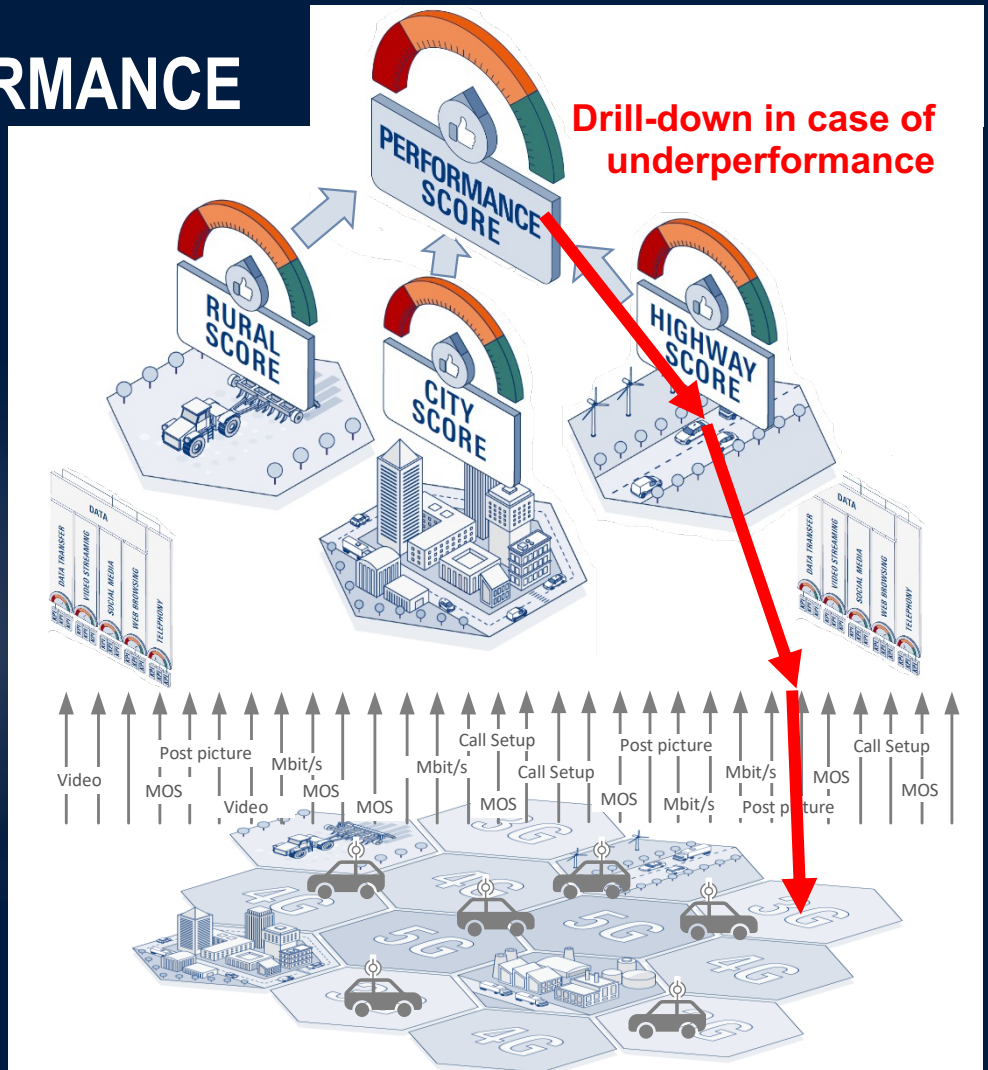

# NETWORK PERFORMANCE SCORE
## SIMPLE CONSTRUCTION PRINCIPLE

| Telephony | Video streaming | Web browsing | Post to Social Media | Pure data transfer |
|---|---|---|---|---|
| **Success** | **Success** | **Success** | **Success** | **Success** |
| **Time** to setup | **Time** to video | **Time** to download | **Time** to upload | **Time** to transfer |
| **Quality** | **Quality** | | | |

*Strongest weight*

*40% in overall*

*Strongest weight of data services*

**General**
- Success counts most for all services
- Time to complete is second most important for all services
- Earning extra points for extraordinary performance
- Losing extra points for weak performance

# ETSI TR 103 559
## ROBUST SCORING NETWORK PERFO

- TR 103 559 describes the methodology, the
  guidance for scoring network's end-to
- TR 103 559 methodology is tech
- Referenced in ITU-T E.804.1 a

- Scoring is based on standardize
  - Telephony: ETSI T
  - Speech Quality: ITU-T P.8
  - Video/YouTube: ETSI TR 1
  - Video Quality: ITU-T J.343.
  - Data Transfer: ETSI TS 102
  - Browsing: ETSI TS 102 25 ETSI TR

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- **Obtaining the KPIs according to standard**
- **Aggregating to Performance Score**
- **Statistical Evaluation**


THANK YOU!